Final

Amendment of Pond Creek *E. coli*, pH and Metals TMDL
Muhlenberg County, Kentucky
TMDL ID #67320

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August 2017

Kentucky Department for Environmental Protection

Division of Water

This report is approved for release

Peter T. Goodmann, Director
Division of Water

8/18/2017
Date

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Muhlenberg County, Kentucky
TMDL ID #67320
August 14, 2017

A. TMDL Background

The document of Total Maximum Daily Load for *E. coli*, pH, Cadmium, Copper, Iron, Lead, Nickel and Zinc, 54 Pollutant-Waterbody Combinations on 25 Stream Segments, Pond Creek, Muhlenberg County, Kentucky (referred to as Pond Creek TMDL in this document), was approved on February 2, 2017 (TMDL ID of 67320). The pollutants caused the impairments for the designated uses of Primary Contact Recreation (PCR), Secondary Contact Recreation (SCR) or Warm Water Aquatic Habitat (WAH). The Pond Creek TMDL adopted equation-based method, i.e. Load = WQS (Water Quality Standard) * flow (in stream) * conversion factor. Original TMDL allocations are presented in Table 1.

Table 1 TMDLs and Allocations by Impaired Segments

Pollutant	Units	TMDL[1]	MOS[2]	KPDES-WLA[3]	LA[4]
Bat East Creek 0.0 to 3.4					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Copper (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.8545*(\ln(\text{hardness}))-1.702)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.8545*(\ln(\text{hardness}))-1.702)}$	$Q_{LA} \times 0.005394 \times e^{(0.8545*(\ln(\text{hardness}))-1.702)}$
Copper (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(0.9422*(\ln(\text{hardness}))-1.700)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.9422*(\ln(\text{hardness}))-1.700)}$	$Q_{LA} \times 0.005394 \times e^{(0.9422*(\ln(\text{hardness}))-1.700)}$
Lead (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$
Lead (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$
Beech Creek 0.0 to 3.9					
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
Iron (Chronic)[5]	pounds/day	$Q_S \times 5.3938$	Implicit	$Q_{KPDES} \times 5.3938$	$Q_{LA} \times 5.3938$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$

Pollutant	Units	TMDL[1]	MOS[2]	KPDES-WLA[3]	LA[4]
Nickel (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+ 0.0584)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+ 0.0584)}$	$Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+ 0.0584)}$
Nickel (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+2.255)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+2.255)}$	$Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+2.255)}$
Zinc (Acute and Chronic)[6]	pounds/day	$Q_S \times 0.005394 \times e^{(0.8473*(\ln(\text{hardness}))+ 0.884)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(\text{hardness}))+ 0.884)}$	$Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(\text{hardness}))+ 0.884)}$
Boggess Creek 0.0 to 3.0					
E. coli	colonies/day	$Q_S \times WQC \times 24,465,758.4$	Implicit	$Q_{KPDES} \times WQC \times 24,465,758.4$	$Q_{LA} \times WQC \times 24,465,758.4$
Caney Creek 0.0 to 3.6					
E. coli	colonies/day	$Q_S \times WQC \times 24,465,758.4$	Implicit	$Q_{KPDES} \times WQC \times 24,465,758.4$	$Q_{LA} \times WQC \times 24,465,758.4$
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
Caney Creek 3.6 to 7.6					
E. coli	colonies/day	$Q_S \times WQC \times 24,465,758.4$	Implicit	$Q_{KPDES} \times WQC \times 24,465,758.4$	$Q_{LA} \times WQC \times 24,465,758.4$
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
Lead (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$
Lead (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$
Carters Creek 0.0 to 3.1					
E. coli	colonies/day	$Q_S \times WQC \times 24,465,758.4$	Implicit	$Q_{KPDES} \times WQC \times 24,465,758.4$	$Q_{LA} \times WQC \times 24,465,758.4$
Opossum Run 0.0 to 1.6					
E. coli	colonies/day	$Q_S \times WQC \times 24,465,758.4$	Implicit	$Q_{KPDES} \times WQC \times 24,465,758.4$	$Q_{LA} \times WQC \times 24,465,758.4$
Plum Creek 0.0 to 1.65					

Pollutant	Units	TMDL[1]	MOS[2]	KPDES-WLA[3]	LA[4]
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$
Plum Creek 1.65 to 3.9					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
pH[7]	standard units	$6.0 \leq pH \leq 9.0$	Implicit	$6.0 \leq pH \leq 9.0$	$6.0 \leq pH \leq 9.0$
Alkalinity, Acidity[8]	mg/L as $CaCO_3$	Net Alkalinity ≥ 0	Implicit	Net Alkalinity ≥ 0	Net Alkalinity ≥ 0
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$
Nickel (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$	$Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$
Nickel (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$	$Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$
Zinc (Acute and Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$	$Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$
Pond Creek 0.0 to 5.0					
Iron (Chronic)[9]	pounds/day	$Q_S \times 18.878$	Implicit	$Q_{KPDES} \times 18.878$	$Q_{LA} \times 18.878$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$
Pond Creek 5.0 to 7.5					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$

Pollutant	Units	TMDL[1]	MOS[2]	KPDES-WLA[3]	LA[4]
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
Iron (Chronic)[5]	pounds/day	$Q_S \times 5.3938$	Implicit	$Q_{KPDES} \times 5.3938$	$Q_{LA} \times 5.3938$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$
Pond Creek 7.5 to 11.7					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
Iron (Chronic)[5]	pounds/day	$Q_S \times 5.3938$	Implicit	$Q_{KPDES} \times 5.3938$	$Q_{LA} \times 5.3938$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$
Pond Creek 11.7 to 14.4					
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
Iron (Chronic)[5]	pounds/day	$Q_S \times 5.3938$	Implicit	$Q_{KPDES} \times 5.3938$	$Q_{LA} \times 5.3938$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$
Pond Creek 14.4 to 18.1					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Lead (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$
Lead (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$
Pond Creek 18.1 to 18.7					

Pollutant	Units	TMDL[1]	MOS[2]	KPDES-WLA[3]	LA[4]
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Saltlick Creek 0.0 to 3.7					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Sandlick Creek 0.0 to 4.05					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Iron (Chronic)[5]	pounds/day	$Q_S \times 5.3938$	Implicit	$Q_{KPDES} \times 5.3938$	$Q_{LA} \times 5.3938$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$
Lead (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$
Lead (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$
UT of Bat East Creek 0.0 to 1.9					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
UT of Bat East Creek 0.0 to 3.55					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
UT of Caney Creek 0.0 to 2.6					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Lead (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$
Lead (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$
UT of Caney Creek 0.0 to 2.35					
E. coli	colonies/day	$Q_S \times WQC \times 24{,}465{,}758.4$	Implicit	$Q_{KPDES} \times WQC \times 24{,}465{,}758.4$	$Q_{LA} \times WQC \times 24{,}465{,}758.4$
Lead (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-4.705)}$

Pollutant	Units	TMDL[1]	MOS[2]	KPDES-WLA[3]	LA[4]
Lead (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$	$Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(\text{hardness}))-1.460)}$
UT of Plum Creek 0.0 to 2.45					
pH[7]	standard units	$6.0 \leq pH \leq 9.0$	Implicit	$6.0 \leq pH \leq 9.0$	$6.0 \leq pH \leq 9.0$
Alkalinity, Acidity[8]	mg/L as $CaCO_3$	Net Alkalinity ≥ 0	Implicit	Net Alkalinity ≥ 0	Net Alkalinity ≥ 0
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
Iron (Chronic)[5]	pounds/day	$Q_S \times 5.3938$	Implicit	$Q_{KPDES} \times 5.3938$	$Q_{LA} \times 5.3938$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$
Nickel (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+ 0.0584)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+ 0.0584)}$	$Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+ 0.0584)}$
Nickel (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+2.255)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+2.255)}$	$Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(\text{hardness}))+2.255)}$
Zinc (Acute and Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.8473*(\ln(\text{hardness}))+ 0.884)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(\text{hardness}))+ 0.884)}$	$Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(\text{hardness}))+ 0.884)}$
UT of Pond Creek 0.0 to 2.4					
Iron (Chronic)[5]	pounds/day	$Q_S \times 5.3938$	Implicit	$Q_{KPDES} \times 5.3938$	$Q_{LA} \times 5.3938$
Iron (Acute)	pounds/day	$Q_S \times 21.575$	Implicit	$Q_{KPDES} \times 21.575$	$Q_{LA} \times 21.575$
UT of Pond Creek 2.4 to 4.2					
E. coli	colonies/day	$Q_S \times WQC \times 24,465,758.4$	Implicit	$Q_{KPDES} \times WQC \times 24,465,758.4$	$Q_{LA} \times WQC \times 24,465,758.4$
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$
pH[7]	standard units	$6.0 \leq pH \leq 9.0$	Implicit	$6.0 \leq pH \leq 9.0$	$6.0 \leq pH \leq 9.0$

Pollutant	Units	TMDL[(1)]	MOS[(2)]	KPDES-WLA[(3)]	LA[(4)]
Alkalinity, Acidity[(8)]	mg/L as $CaCO_3$	Net Alkalinity ≥ 0	Implicit	Net Alkalinity ≥ 0	Net Alkalinity ≥ 0
UT of Pond Creek 0.0 to 1.4					
Cadmium (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$	$Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(\text{hardness}))-4.719)}$
Cadmium (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$	$Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$

(1) TMDLs for *E. coli* are expressed as the flow in the stream, Q_S in ft^3/s, multiplied by the WQCs: i) 240 *E. coli* colonies/100 ml which must be met in at least 80% of all samples taken within a 30-day period during the Primary Contact Recreational season of May through October; ii) 130 *E. coli* colonies/100 ml as a geometric mean based on not less than 5 samples taken within a 30-day period during the Primary Contact Recreational season of May through October. Then the multiple of Qs and WQC is converted into *E. coli* load (colonies/day) by multiplying the conversion factor of 24,465,758.4. TMDLs for metals are expressed as the flow in the stream, Q_S in ft^3/s, multiplied by the WQC in mg/L or µg/L and the appropriate conversion factor to convert the multiple of flow and the WQC into units of load (pounds/day). The conversion factors are: iron, chronic = 5.3938 (when the WQC of 1.0 mg/L is applied) or 18.8782 (when the WQC of 3.5 mg/L is applied); iron, acute = 21.575; cadmium, copper, lead, nickel and zinc, chronic and acute = 0.005394. Also, pH must remain between 6.0 and 9.0 standard units, inclusive.

(2) The MOS is implicit, see Section 7.3 of the Pond Creek TMDL.

(3) The KPDES-WLA for *E. coli* is expressed as the flow in the stream due to KPDES-permitted sources with *E. coli* permit limits, Q_{KPDES} in ft^3/s, multiplied by the WQCs and the conversion factor to convert the multiple of flow and the WQC into the unit of load (colonies/day). All KPDES-permitted dischargers must meet both instantaneous and geomean *E. coli* WQCs. The KPDES-WLA for metals is expressed as the flow in the stream due to KPDES-permitted sources with permit limits for the pollutants addressed by the Pond Creek TMDL, Q_{KPDES}, in ft^3/s, multiplied by the WQC and the appropriate conversion factor. All KPDES-permitted dischargers must meet both the chronic and acute criteria for pollutants addressed by the TMDL whose WQCs are expressed in both chronic and acute terms. New or expanded KPDES-permitted dischargers with reasonable potential will be allowed contingent upon them meeting WQCs of the pollutants addressed in this document.

(4) The LA is expressed as the flow in the stream from natural background or due to legal but non-KPDES-permitted sources of the pollutants addressed by this TMDL, Q_{LA}, in ft^3/s, multiplied by the WQC and the appropriate conversion factor, see Section 5.2 of the Pond Creek TMDL.

(5) The chronic iron WQC is 1.0 mg/L since the aquatic life is adversely affected. The acute iron WQC is not dependent on impacts to aquatic life; it is 4.0 mg/L in all streams.

(6) The chronic and acute WQCs for zinc are identical.

(7) pH can be converted to a range of allowable loads of hydrogen ions in units of g/day (gram per day); a pH of 6.0 represents a maximum allowable load of hydrogen ions equal to $Q_S \times 2.906$ g/day, and a pH of 9.0 represents a minimum allowable load of $Q_S \times 2.906E\text{-}3$ g/day, where Q_S is the flow in the stream in ft^3/s. The TMDL can then be allocated to the KPDES-WLA and the LA based on the fraction of the streamflow each contributes.

(8) Net alkalinity is defined as the alkalinity in mg/L as $CaCO_3$ minus the calculated acidity; the calculated acidity is determined using the following equation: Calculated Acidity, mg/L as $CaCO_3 = 50 \times ((10^{(3\text{-pH})}) + (3 \times \text{Fe mg/L}/55.8) + (2 \times \text{Mn mg/L}/54.9) + (3 \times \text{Al mg/L}/27))$. Monitoring and reporting of net alkalinity will be required both instream and at outfalls at the same frequency as iron and manganese are monitored and reported. Aluminum must be added to KPDES mining permits as report-only in order to determine the calculated acidity. Net alkalinity must be greater than or equal to zero (in both mg/L and pounds/day) in order to buffer metals hydrolysis which can lower pH below acceptable levels.

(9) The chronic iron WQC is 3.5 mg/L since the aquatic life has not been shown to be adversely affected. The acute iron WQC is not dependent on impacts to aquatic life; it is 4.0 mg/L in all streams.

B. Purpose of Proposed Amendment

The segment of Beech Creek 0.0 to 3.9 was addressed in the Pond Creek TMDL with the pollutants of cadmium, iron, nickel and zinc. Those pollutants caused impairment for the Warm Water Aquatic Habitat (WAH). However, the Pond Creek TMDL did not address copper, which was also listed as a pollutant source for WAH impairment on Beech Creek 0.0 to 3.9 in 2016 303(d) List. The purpose of this amendment is only to address copper on Beech Creek 0.0 to 3.9. This amendment TMDL does not otherwise affect the original Pond Creek TMDL.

C. Justification for Amendment

The information for the segment of Beech Creek 0.0 to 3.9 can be obtained from Section 8.2 of the Pond Creek TMDL. Water Quality Standard of copper for WAH Designated Use can be found in Section 6.2 of the Pond Creek TMDL. The development methodology for TMDL of this amendment is the same as the methodology of the Pond Creek TMDL (Section 7.0). Table 2 lists the copper sampling data collected by TMDL staff at DOW03011015 (Figure 1).

Table 2 Copper and Flow Data Collected at DOW03011007

Date	Copper (µg/L)	Hardness, Total (mg/L)	Copper Chronic Limit (µg/L)	Copper Acute Limit (µg/L)	Difference between the Copper Concentration and the Copper Chronic Limit (µg/L)	Flow (cfs)
11/17/2010	26.7	779	53.91	96.85	-27.21	**
1/5/2011	12.9	386	29.58	49.98	-16.68	0.676
2/16/2011	10.2	330	25.88	43.12	-15.68	0.903
3/9/2011	8.72	117	10.67	16.23	-1.95	**
4/27/2011	10.6	97.9	9.16	13.72	1.44	**
5/11/2011	97	1400	88.96	168.26	8.04	1.934
6/15/2011	93.3	1310	84.05	158.05	9.25	0.167
7/13/2011	70.6 (D)	417	31.60	53.75	39.00	0.135
3/26/2013	9.94	169	14.61	22.95	-4.67	2.560
4/24/2013	7.4	107	9.88	14.92	-2.48	**
6/27/2013	22.4	923	62.32	113.63	-39.92	0.419
7/17/2013	29.8	415	31.47	53.51	-1.67	0.209
8/6/2013	30.4	803	55.32	99.66	-24.92	**
10/10/2013	7.58	425	32.12	54.72	-24.54	0.293
11/13/2013	9.6	625	44.66	78.70	-35.06	0.159
12/17/2013	6.24	324	25.47	42.38	-19.23	0.843

Date	Copper (µg/L)	Hardness, Total (mg/L)	Copper Chronic Limit (µg/L)	Copper Acute Limit (µg/L)	Difference between the Copper Concentration and the Copper Chronic Limit (µg/L)	Flow (cfs)
3/18/2014	11.6	408	31.02	52.66	-19.42	1.521
4/15/2014	11	262	21.25	34.69	-10.25	3.973
5/21/2014	11.1	531	38.85	67.50	-27.75	0.495
6/5/2014	6.16	370	28.53	48.02	-22.37	0.902
10/29/2014	7.05	588	42.39	74.30	-35.34	**
11/19/2014	7.53	608	43.62	76.68	-36.09	**
12/23/2014	6.96	435	32.77	55.93	-25.81	0.643

Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution

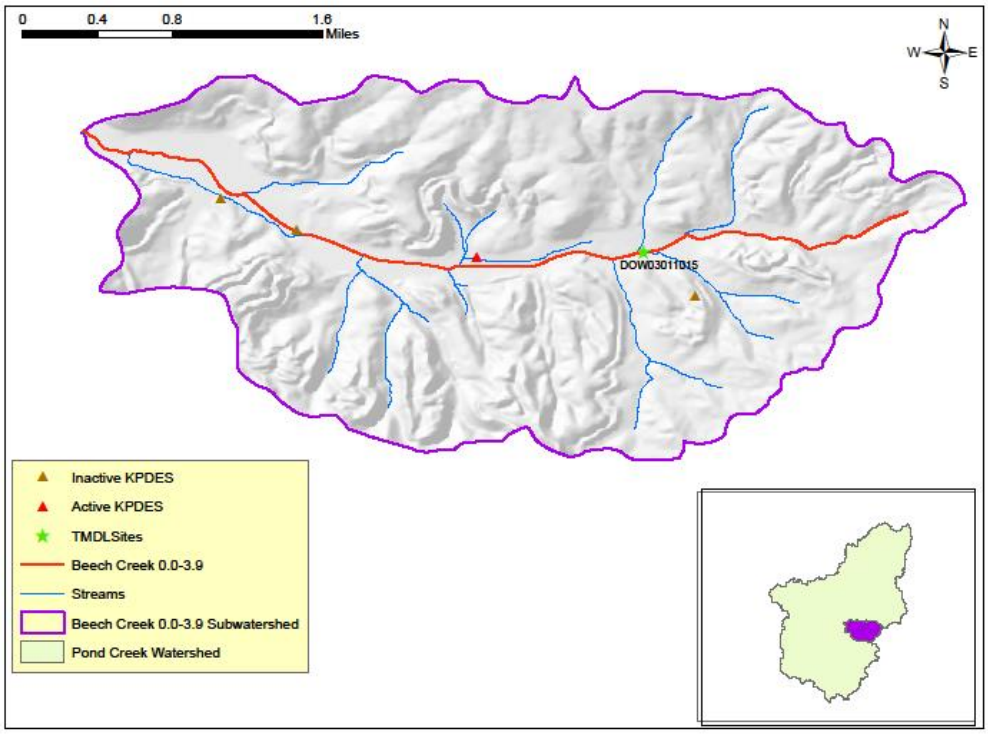

Figure 1 Streams, TMDL Site, and KPDES Permittees in the Beech Creek 0.0 to 3.9 Subwatershed

D. TMDL Allocations in This Amendment

Table 3 lists TMDL loading allocations for the Beech Creek 0.0 to 3.9.

Table 3 Beech Creek 0.0 to 3.9 TMDL Allocations

Pollutant	Units	TMDL[(1)]	MOS[(2)]	KPDES-WLA[(3)]	LA[(4)]
Copper (Chronic)	pounds/day	$Q_S \times 0.005394 \times e^{(0.8545*(\ln(\text{hardness}))-1.702)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.8545*(\ln(\text{hardness}))-1.702)}$	$Q_{LA} \times 0.005394 \times e^{(0.8545*(\ln(\text{hardness}))-1.702)}$
Copper (Acute)	pounds/day	$Q_S \times 0.005394 \times e^{(0.9422*(\ln(\text{hardness}))-1.700)}$	Implicit	$Q_{KPDES} \times 0.005394 \times e^{(0.9422*(\ln(\text{hardness}))-1.700)}$	$Q_{LA} \times 0.005394 \times e^{(0.9422*(\ln(\text{hardness}))-1.700)}$

1) TMDLs for copper are expressed as the flow in the stream, Q_S in ft3/s, multiplied by the WQC in µg/L and the conversion factor (0.005394) to convert the multiple of flow and the WQC to units of load (pounds/day).
2) The MOS is implicit, see Section 7.3 of the Pond Creek TMDL.
3) The KPDES-WLA is expressed as the flow in the stream due to KPDES-permitted sources, Q_{KPDES}, in ft^3/s, multiplied by the WQC and the conversion factor. All KPDES-permitted dischargers must meet both the chronic and acute copper criteria. New or expanded KPDES-permitted dischargers with reasonable potential will be allowed contingent upon them meeting copper WQCs.
4) The LA is expressed as the flow in the stream from natural background or due to legal but non-KPDES-permitted sources, Q_{LA}, in ft3/s, multiplied by the WQC and the conversion factor.

E. Other Considerations

Surface mining was listed as the suspected copper source for Beech Creek 0.0 to 3.9. The Pond Creek TMDL addressed the mining status within the Beech Creek 0.0 to 3.9 subwatershed, see Section 8.2. Also, Section 9.4 of the Pond Creek TMDL discussed the mining related implementations.

F. Public Participation

The Pond Creek TMDL was published for a 30-day public notice period from November 10, 2016 to December 10, 2016 with no comments received. The Pond Creek TMDL was approved on February 2, 2017. No additional KPDES facilities are affected by this amendment TMDL. This amendment applies same methodology as that implemented in the EPA approved Pond Creek TMDL document. Copper was listed as a pollutant contributing the WAH impairment on Beech Creek 0.0 to 3.9 as a part of the 2016 303(d) List. The 2016 303(d) List was placed on a 60-day public notice starting on May 2, 2017.

This amendment was published for a 30-day public notice from July 7, 2017 to August 7, 2017, and no comments were received.